Developmental Testbed Center: Facilitating R2O for Numerical Weather Prediction

Louisa Nance[1], Bill Kuo[1], Jamie Wolff[1], Ligia Bernardet[2], and Hui Shao[1]

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1.   National Center for Atmospheric Research
2.   Earth System Research Laboratory

DTC Developmental Testbed Center

What is the DTC?

- **Purpose**: Facilitate the interaction & transition of NWP technology between research & operations
  - **O2R**: Support operational NWP systems to the community
  - **R2O**: Perform T&E on promising NWP innovations for possible operational implementation
  - **Interaction between R & O**: Workshops, Visitor Program, Newsletter
- Jointly sponsored by NOAA, Air Force, NSF, & NCAR
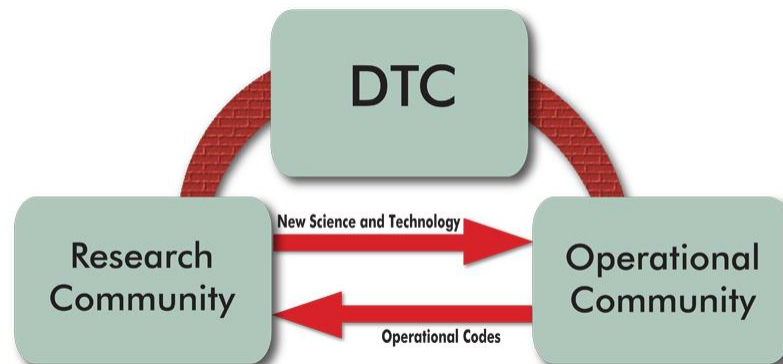
Workshop on Parameterization of Moist Processes for Next-Generation NWP Models

Goal: Inform & advise the future directions of moist process parameterization development, w/ emphasis on NWP applications for scales & resolutions ranging from synoptic-scale to convective permitting scale

Organizing committee: Jamie Wolff (DTC), Yu-Tai Hou (EMC), Jim Doyle (NRL), Robert Pincus (CIRES)

27-29 January 2015 @ NCWCP, College Park, MD

80+ scientists from leading centers around the world

In-depth discussions on state-of-the-science and current operational status at NCEP for microphysics, sub-grid scale clouds and turbulence, and deep convection

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3

DTC Visitor Program

- Supports visitors to work w/ the DTC to test new forecasting & verification techniques, models & model components for NWP
  - PI project – up to 2 months salary & travel & per diem
  - Graduate student project - up to 1 year temporary living per diem stipend & travel expenses for student to work w/ DTC &/or one of its partners + travel & per diem for up to 2 2-week visits to the location of the student by project PI
- Avenue for connecting with subject-matter-experts to collaborate with DTC on T&E activities

http://www.dtcenter.org/visitors/

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Software Systems

➢ Include capabilities of operational system
➢ Distributed development
➢ Code management plans

Verificaton Tools

Current foci:
mesoscale modeling, hurricanes, data assimilation & ensembles – adding global this year

Testing and Evaluation

➢ Diagnostics of current operational systems
➢ Performance of new innovations

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Software system philosophy

- Shared resource w/ distributed development that includes capabilities of current operational systems
- On-going development maintained under mutually agreed upon software management plan
  - Code repository maintained under version control software
  - Protocols for proposing & approving modifications to the software
    - Testing standards
    - Code review committee
  - Additional testing standards to more thoroughly check integrity of evolving code base
- Centralized support (in collaboration with developers)
  - Software downloads
  - Documentation
  - Email helpdesk
  - Tutorials (online and onsite)

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Current Software Systems

Software	Type	Developers	Repository	DTC's role
WRF	mesoscale model	NCAR, GSD	NCAR	Assist w/ rep maintenance & community contributions
UPP	post-processor	EMC	EMC Community	Maintain community repository (sync & portability) Community support
NMMB	mesoscale model	EMC	EMC DTC	Portability & friendly user releases Assist w/ community contributions Documentation
GSI-EnKF	data assimilation	EMC, NASA, GSD, NCAR, NESDIS	EMC Community	Chair DA Review Committee Maintain community repository (sync & portability) Assist w/ community contributions Community support
HWRF	tropical cyclone	EMC, HRD, URI, GFDL	Community (10 components)	Chair HWRF Developers Committee Transition ops capability to component repositories Repository maintenance Support for system run scripts Community support
MET	verification	NCAR	NCAR	Maintain repository and advance capability Community support

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Examples of how DTC is engaging the research community

In the context of
- T&E feedback loop, including new/modified capabilities and diagnostic tools
- Providing assistance to community developers
- Providing framework for research community T&E

DTC's role in HWRF development: connecting the pieces

2013
- DTC tests HWRF w/ RRTMG/Thompson – mixed results w/ degradations in the eastern North Pacific
- EMC tests RRTMG – poor results for bundled tests

2014
- Fovell (UCLA-DTC visitor) works with DTC to performs diagnostics and suggests improvements to eddy mixing
- DTC performs diagnostics & implements subgrid-scale cloudiness scheme to address missing cloud-radiation interactions
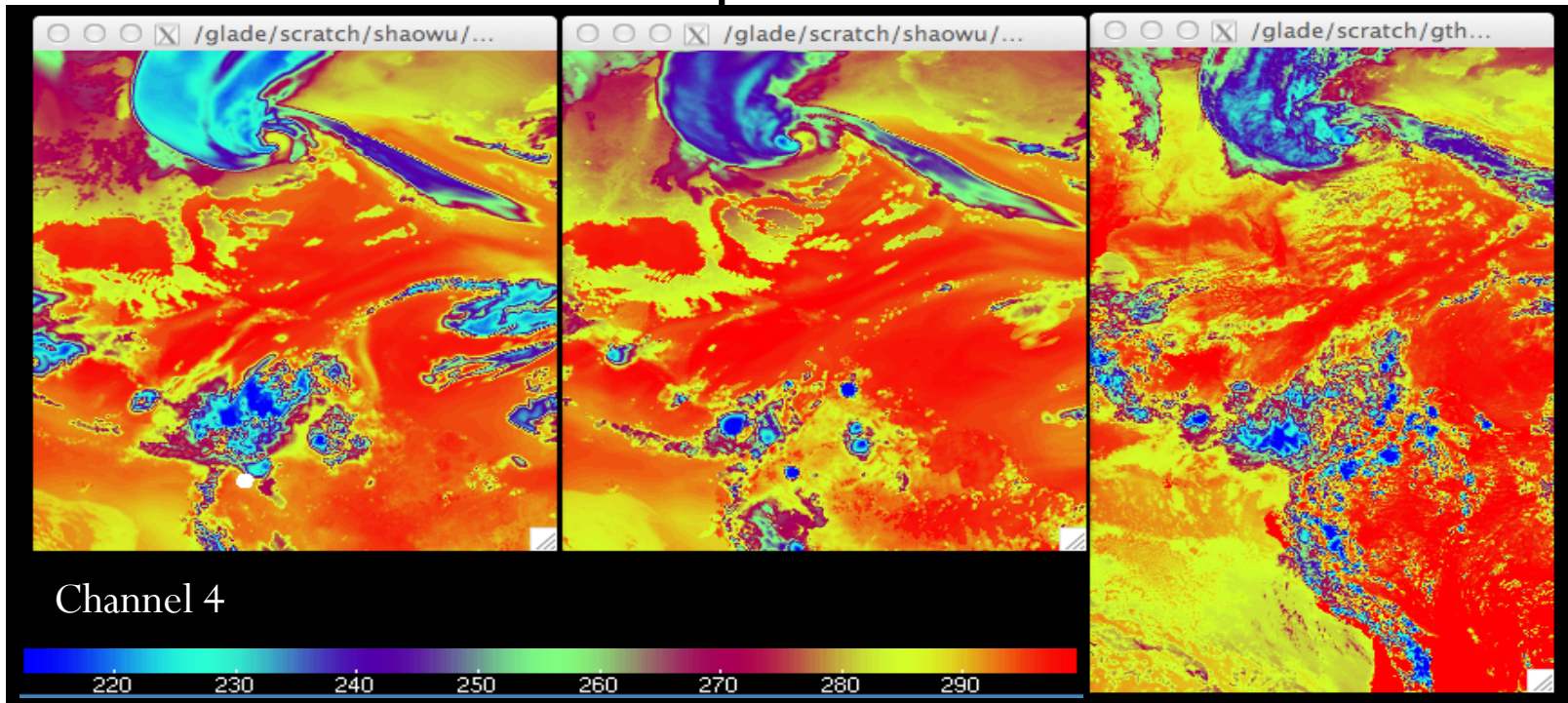
2015
- Eddy mixing and subgrid-scale cloudiness schemes delivered to EMC for potential 2015 pre-implementation testing

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Development of additional diagnostics

Ferrier+GFDL **Thompson+RRTMG** **Observed satellite**

Channel 4

220	230	240	250	260	270	280	290

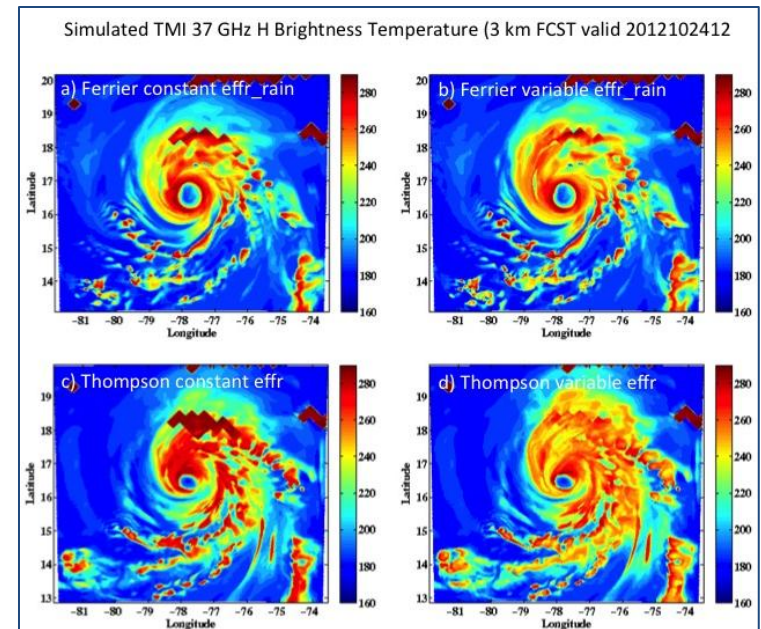**S. Bao (SCCU – DTC visitor): UPP & modified CIMSS synthetic satellite simulator provide a framework for comparing Ferrier & Thompson**

Acknowledgements to Jason Otkin

10

Assisting community with software system contributions

- J. Otkin's team at U. Wisconsin CIMSS (HFIP grant) added innovations to UPP – the NCEP Unified Post Processor, used by all NCEP models

- DTC's role

  - Connect U. Wisconsin team with UPP and CRTM developers at NCEP for planning

  - Assist U. Wisconsin team with incorporating developments into HWRF code repository

- Added sensors for synthetic satellite images

  - GOES-13 and GOES-15 imagers, channels 2-5

  - (MSG) SEVIRI imager , channels 5-11

  - (F13-15) SSMI, channels 1,2,4,5,6,7

  - (F16-F20) SSMIS, channels 9,12,13,15,16,17,18

- Improved computation of hydrometeor effective radii

- User configuration files simplified

Simulated TMI 37 GHz H Brightness Temperature (3 km FCST valid 2012102412

a) Ferrier constant effr_rain
b) Ferrier variable effr_rain
c) Thompson constant effr
d) Thompson variable effr

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Mesoscale Model Evaluation Testbed (MMET)

Why: Assist the research community in efficiently demonstrating the merits of a new development

- Provide a common framework for testing; allow for direct comparisons

What: Mechanism to efficiently *assist* research community *with initial stage of testing*

- Provide model input and observational datasets to utilize for testing

- Establish and publicize baseline results for select operational models

Where: Hosted by the DTC; served through **R**epository for **A**rchiving, **M**anaging and **A**ccessing **D**iverse **DA**ta (RAMADDA)
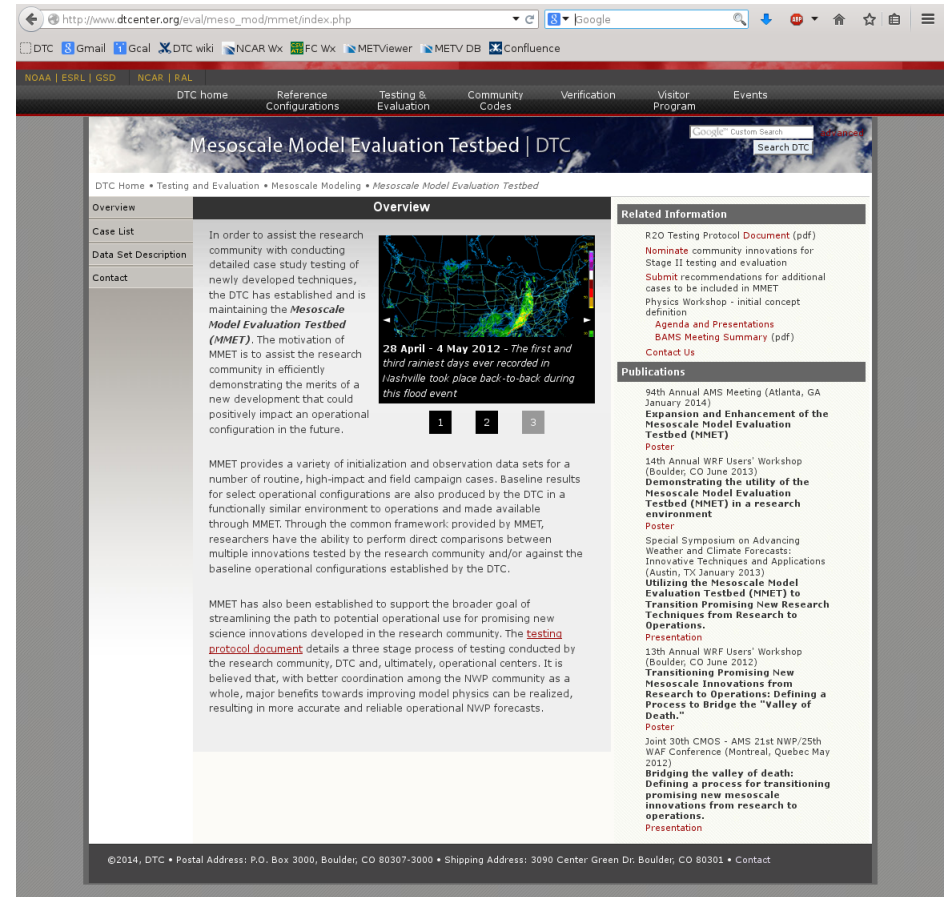
http://www.dtcenter.org/eval/meso_mod/mmet/index.php

MMET – Case Inventory

Date(s)	Meteorological Scenario
20090228	Mid-Atlantic *snow storm* -NAM high QPF shifted too far north
20090311	*High dew point* predictions by NAM over the upper Midwest and in areas of snow
20091007	*HIRESW* runs *underperformed* compared to coarser NAM model
20091217	"*Snowpocalypse '09*"
20100428–0504	Historic Tennessee *flooding* associated w/ an atmospheric river
20110404	Record breaking *severe* report day
20110518–26	Extended *severe weather* outbreak covering much of the Midwest and into the eastern states
20111128	*Cutoff low* over SW US
20120203–05	*Snow storm* over Colorado, Nebraska, etc.
20120628	*Derecho* event that began in Iowa and traveled eastward through the Mid-Atlantic states
20130729	*Mesoscale convective system* (MCS) over SE Kansas
20130908–14	Historic Colorado *flooding* associated w/ long duration and warm rain processes
20140105	*Arctic air outbreak* impacting much of the United States east of the Rockies

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MMET – Community Use
User Cases – Kelly Mahoney (CIRES)

Case Details: 1 – 3 May 2010 **Flooding in TN**

Forecasts: Simulations #1-3: 15-km grid length; Simulation #4: 4-km grid length/1.3-km inner nest
1. WRF v3.5 ARW baseline (MMET Baseline Configuration w/ *WSM5*)
2. WRF v3.5 ARW namelist w/ *Thompson* microphysics
3. WRF v3.5 ARW namelist w/ *Thompson* microphysics and *no CP scheme*
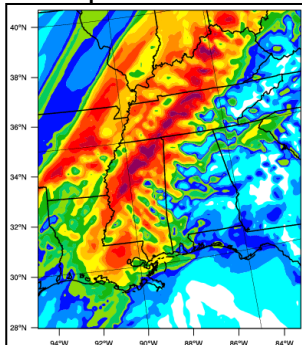4. WRF v3.5 ARW namelist w/ *#3 physics* and *4-km/1.3-km grid length*

Model Initialization: Utilized IC/BC files from DTC for simulations #1–3, NAM 00 UTC 20100501 forecast from DTC to produce IC/BCs for #4

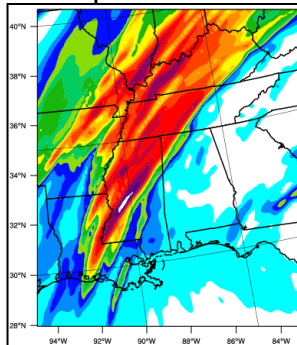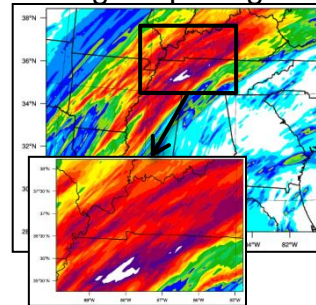## 48-h Total Precipitation Accumulation
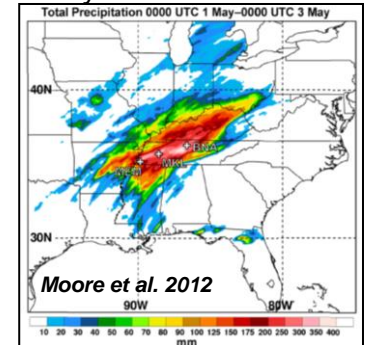

MMET Baseline
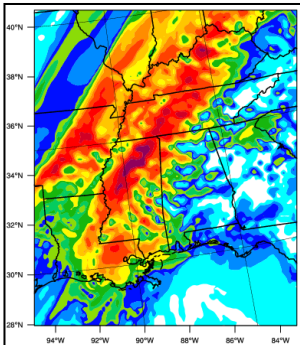
Thompson

Thompson + no CP

4-km grid spacing

1.3-km grid spacing

Analyzed

Moore et al. 2012

Case Summary

- Strong synoptic-scale dynamical forcing; all simulations generate precipitation maxima > 150 mm
- Significant over-forecast of precip found in LA and AR in all runs; timing error vs. location error?
- KF CP scheme generates NW-SE-oriented precip banding not seen in explicit convection runs
- Increased horizontal resolution increases precipitation maxima

Summary

- The DTC is a community facility with a mission to accelerate the transition of new NWP technology into operations
  - Maintains & supports community modeling systems for research & operational NWP communities (O2R)
  - Facilitates and conducts testing and evaluation of new innovations (R2O)
  - Facilitates interactions between research & operational NWP
    - Workshops
    - DTC Visitor Program

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THANK YOU!

http://www.dtcenter.org/

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